# Soyuz Occupant Risk

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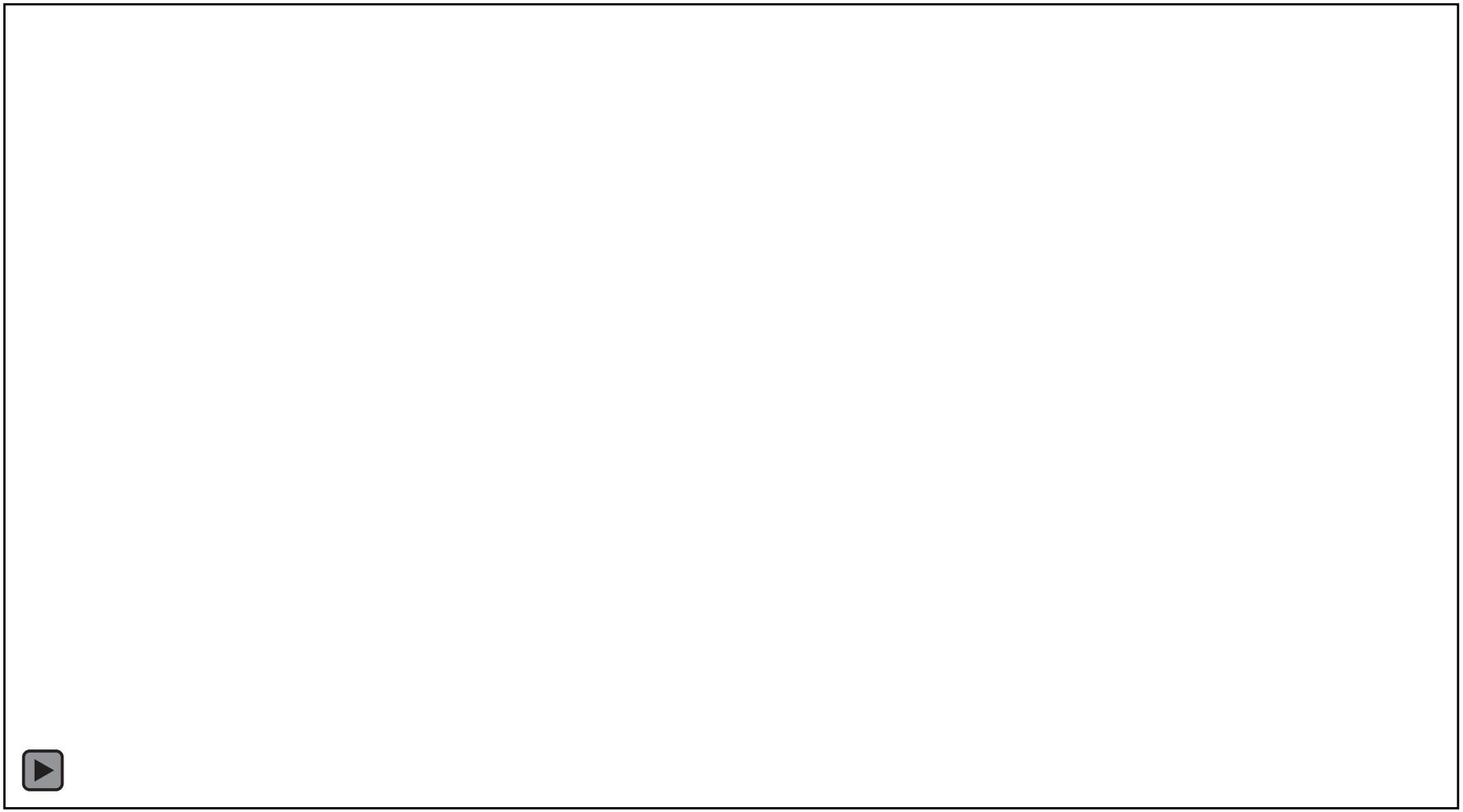
# Project Overview

- Spaceflight has unique challenges for Occupant Protection
- Current NASA Occupant Protection Requirements are based on military and automotive biodynamics research
  - Brinkley Dynamic Response Criteria
  - Hybrid III Anthropomorphic Test Device (ATD)
- Soyuz offers unique insight into the role of spaceflight deconditioning on impact tolerance
- Project Objectives
  1. Develop a landing injury database
  2. Obtain seat acceleration data from TMA landings
  3. Re-create Soyuz landings using models
  4. Update NASA occupant protection standards as needed

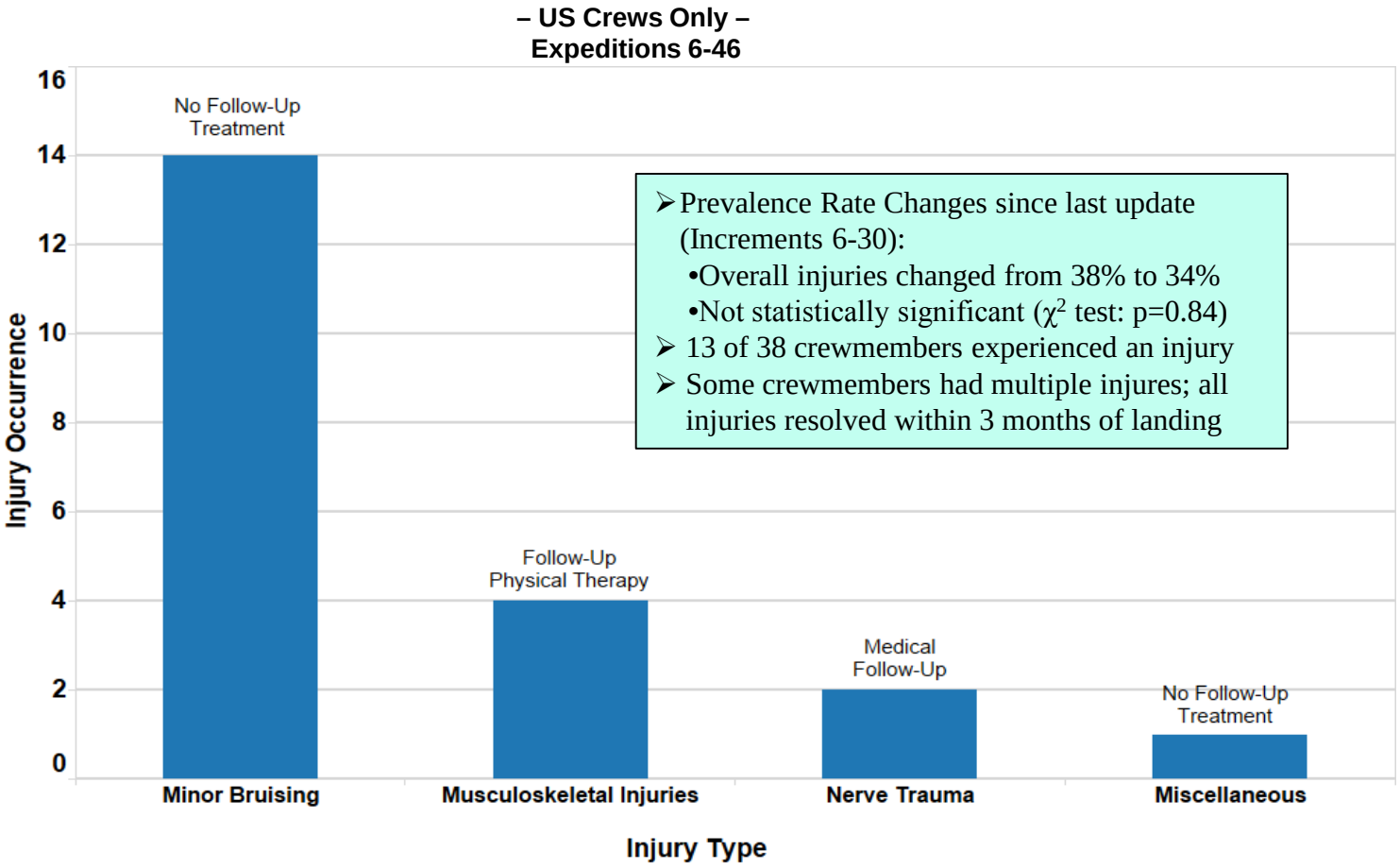
# Soyuz TMA-15M Landing





Source: YouTube

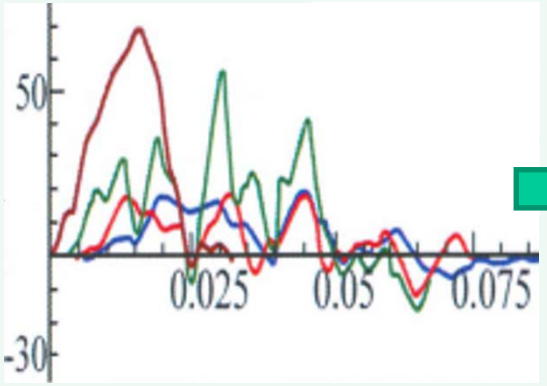
# Soyuz Landing Injury Occurrence



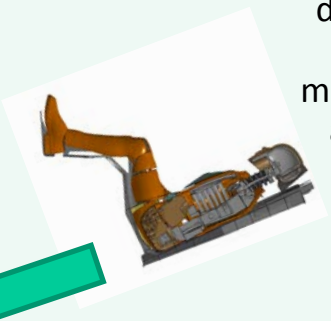

Source: LSAH, Injury due to Dynamic Loads Human System Risk

# Project Approach

## Obtain actual seat accelerations

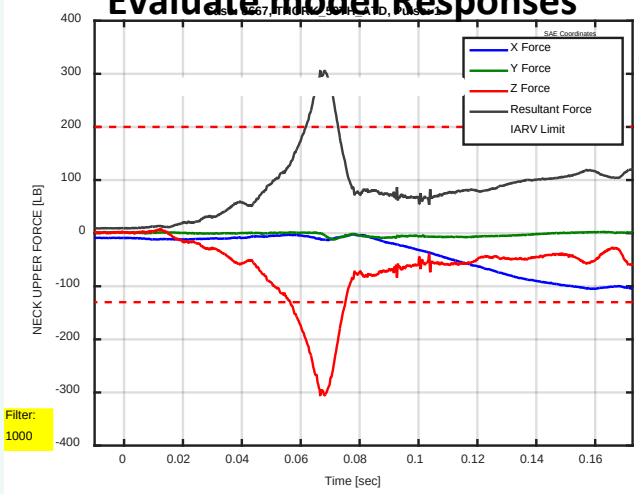



## Create Model of Seat and Suit



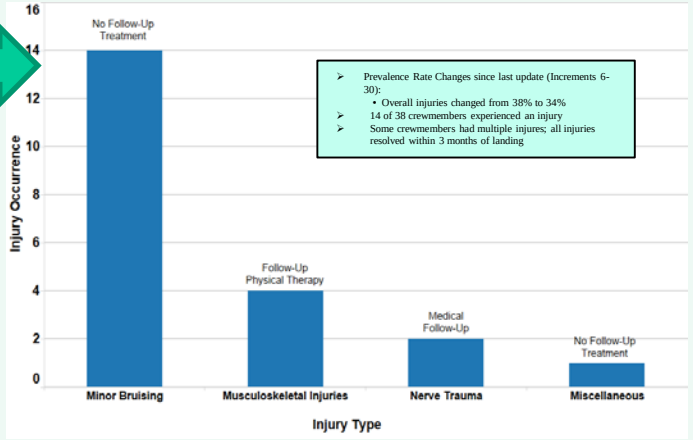
Re-create each Soyuz landing by driving dummy and human models with seat accelerations

## Evaluate model Responses




## Compare results to injury outcomes

– US Crews Only –



# Injury Outcome Data Sources

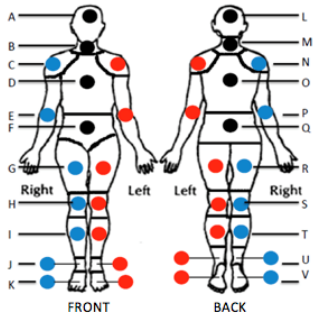
- **Retrospective and Prospective**
  - **Survey filled out by all USOS crewmembers who consent to the study**
  - **Any medical injuries due to landing, and any treatments [provided by LSAH]**
  - **Any pre-existing conditions that may have contributed to an injury**
  - **Flight surgeon perspectives on the landing and any associated injuries**
- **Prospective**
  - **Data share the Soyuz R+0 Flight Observations Form data**

MEDICAL SIGNS, SYMPTOMS, AND INJURIES

*In the table below, please document any symptoms experienced or injuries sustained during re-entry and landing, including minor injuries like bruising.*

| Sign, Symptom, or Injury | Time (GMT) or Setting | Anatomic Location | Severity / Discomfort | Comments |
|---|---|---|---|---|
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |

Anatomic Location Map




| Severity / Discomfort Score | |
|---|---|
| 0 | No symptom awareness / discomfort |
| 1 | Symptom awareness / mild discomfort without performance impact |
| 2 | Symptom present / moderate discomfort without performance impact |
| 3 | Symptom present / moderate discomfort and interferes with performance |
| 4 | Symptom present / severe discomfort and interferes with performance |

# Summary

- **The Soyuz offers unique insight into spaceflight deconditioning and its contribution to landing impact tolerance**
  - **Catalog injuries incurred during landing impact**
  - **Correlate injuries with actual landing accelerations**
  - **Determine if current NASA requirements mitigate the risk of injury to crewmembers**
- **Correlating injury types and incidences with the actual accelerations will greatly inform the models and occupant protection requirements**